BILKENT UNIVERSITY
DEPARTMENT OF COMPUTER ENGINEERING

SENIOR DESIGN PROJECT

Project Specifications Report

Horus

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1. Introduction

The development and adoption of Internet of Things is a critical element of data driven decision making. However, most of the technology to capture and track sensor measurements are developed and installed aren't connected to the internet and can only be seen by measurement panels. Real-time tracking of the data generated by legacy systems is impossible without changing whole system. In this project, we propose an interim technology to track legacy control panels without adding big overhead by using a simple camera and image processing techniques that will bring power of the cloud and big data analytics to help our customers with the analysis of the data they accumulated from their sensor screens.

1.1. Description

Measurement panels of our interest are quite diverse and used for all kinds of application from dc voltage panels to heat measurement panels used in hospital refrigerators. We are going to provide an end to end solution, from the hardware device that will track the current system to big data analytics tool to make sense of the data, that will connect current measurement system to our cloud and an analytics dashboard for our customer.

The data collection on the legacy systems will be handled by a user-end device, called the appliances that will consist of devices such as Arduino [1] or Raspberry Pi [2], one of which will be chosen for the implementation based on the requirements of such work. The appliance contains the necessary camera module to take images of the legacy (analog) sensors, processing power to extract the data from the image using image processing techniques and a communication module to send the sensor

data to the remote center (cloud) in which this data is analyzed according to the needs of the customers, and become ready to be reviewed by the customers.

The project involves work in many different domains of computer science. To extract the sensor data from the image a elegant and fault tolerant image processing system that can be executed with the limited processing power of the appliances should be developed, in order to send the data to the cloud wireless communication techniques via GSM or Wi-Fi should be used, additionally to send the data in a safe way, encryption techniques should be deployed. On the cloud side, the tools of data analytics, big-data should be used to make a meaning from the data according to the customers' requirements, and finally in order to present their sensor data and the analytics to the customers, a clear, easy-to-use and understandable user interface should be designed and implemented. Also cloud system should be robust, fault-tolerant and able to handle large throughputs, since, in ideal case, there will be lots of sensors and the data gathered from sensors is sensitive in business aspect.

Image 1: A typical legacy sensor [3]

1.2 Constraints

The main constraints of the system is technical constraints that involve the software and hardware component that will be used in the project, functional constraints that involve the functionality that the system will provide to the customers, and finally the economical constraints that involve the marketability, sustainability and the customers of the project.

1.2.1 Technical & Functional Constraints

The technical and functional constraints will be separated on two parts based on the main two parts of the project, the appliances that will be attached to the sensors to extract the sensor data and the remote center that the sensor data will be collected, analyzed and presented to the customers with an interface.

1.2.1.1 Appliances

As the appliances that collect the sensor data and send to the remote center need to work on remote, hard to reach areas:

- The appliances should operate on battery power for at least two weeks in order to be a real automation over the current practises.
- The appliances should be durable against weather conditions and physical conditions as they might need to work under tough circumstances.
- The appliances should work persistently as they might be the only medium of accessing the data of sensors that they read, and they should be safe against failure.
- The appliances should be aware of their failure conditions (low battery, hardware/software failure etc.) and must alert the center under such circumstances in order to ensure that the needed maintenance could be performed on them.
- The appliances should support remote firmware / configuration updates, as they might not be available for a near (through direct access) updates.
- The appliances should be able to operate on minimum resources in order to prolong the battery life.
- The algorithms that will be executed on the appliances to extract the sensor data from visual data should be as efficient and accurate as possible, in order to ensure persistency, correctness and also to save the battery life.

1.2.1.2 Remote Center (Cloud)

As the remote center will manage the appliances, and also be the main interface of the system to the customers:

- Remote center should be able to handle the volume of data that is transmitted from appliances.
- Remote center should provide a clear and understandable interface to the customers, as it is the main medium of access to the sensors that the customer have.
- Remote center should provide necessary data analysis tools to the customers (plotting tools, statistical tools etc.) in order to enable the customers to keep track of their sensor data in a useful and meaningful way.
- Remote center should be in contact with the appliances all the time with a handshake mechanism to ensure the failure safety of the system.
- Remote center should be able to send data to the appliances such as firmware, configuration updates.

1.2.2 Economical Constraints

- As the customers have to rent / buy the appliances of the system to attach their sensors, the appliance hardware must be as affordable as possible.

- The appliances should be modular in order to provide only as much as the customer needs. For example if the battery packs are not needed because of the availability of the electricity, then the appliances will need to be adjusted accordingly.

- In order to be preferred by the customers over their traditional, existing methods to handle the goal (to collect sensor data), the cost of the overall implementation should be less, or it should be justify the additional costs by providing extra utilities and functionality.

1.3 Professional & Ethical Issues

One of the biggest ethical issue in this project is ensuring the data privacy, persistence, correctness and safety for the costumers since this system will be their main medium to access their sensor data which may be a sensitive and confidential data, such as a data from a nuclear plant or a military facility.

Thus in order to handle these ethical issues about data privacy, we will employ encryption on both the appliances and the remote center, also we will ask for guidance from one of our faculty members that can help us about data privacy issues. Also in order to ensure the data correctness, we will deploy error detection and correction utilities again both in appliances and the remote center, which will help us and our customers to collect the accurate data, persistently.

2. Requirements

2.1 Functional Requirements

2.1.1 Dashboard

- Users will be able to add appliances (end-point clients) to their monitoring system.
- Users will be able to see whether specific appliances are working or not.
- Dashboard will provide statistical data to users.

- Users will be able to specify threshold values for specific sensors.
- Dashboard will provide an alarm in case of a sensor's threshold value is reached.

2.1.2 Appliances (End-point clients)

- Appliances will be able to inform remote center about their status (in terms of battery power status etc.).
- Appliances will be able to get image data from analog sensors and transfer it to the remote center for processing.
- Appliances will be able to collect data from digital sensors deployed in the legacy system.
- Appliances will be able to report data with adjustable frequencies chosen by customers.
- Appliances will be remotely instructed to transfer data from specific sensors.

2.2 Non-functional Requirements

- Remote center should contain data securely.
- Remote center should be able to handle requests from appliances within 5 seconds.
- Appliances should be able to run on battery power for at least two weeks.
- Appliances should be able to hold data as long as the transfer to remote center is not finished.
- Remote center should keep redundant copies of it's database.
- Remote center should be fault tolerant, the system as a whole should not shutdown in case of specific module failures.

3. References

[1]: https://www.arduino.cc/en/Main/Products
[2]: https://www.raspberrypi.org/help/what-is-a-raspberry-pi/
[3]: http://thumbs.dreamstime.com/z/sensor-5293924.jpg